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EAST EUROPE REPORT

SCIENTIFIC AFFAIRS

No. 650

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CZECHOSLOVAKIA

TESLA INTEGRATED CIRCUIT PRODUCTION ITEMIZED

East Berlin NACHRICHTENTECHNIK-ELEKTRONIK in German Vol 29 No 5, May 79 pp 209-212 manuscript received 4 Dec 76

[Report by J. Vasenda, Rozenov, CSSR, presented at the GDR Chamber of Technology Conference on "Microelectronics Components", held 5-6 Oct 78 in Dresden: "TESLA Integrated Circuits"]

[Text] Descriptors: Integrated circuits, linear, logic, bipolar, MOS, state of the art, propects, production, CSSR.

The purpose of this paper is to provide information on the state of the art and the outlook for the production of integrated circuits in the CSSR. In addition to the summarizing review of the product line assortment, the circuits included in the production and developmental programs of TESLA are also indicated.

1. Linear Integrated Circuits

The production program of linear integrated circuits encompasses types for consumer goods and industrial electronics. Practically all variants of the three stage amplifiers, which were produced in the CSSR as the first integrated circuits, belong to the all-purpose types.

Included among the most widely disseminated types are the MAA501 to 504 operational amplifiers (similar to the μA709). On the basis of the good experience with these operational amplifiers, TESLA developed the MAA725 operational amplifier for industrial electronics (similar to the μA725). TESLA is also preparing subtypes designated with the letters B and C. Moreover, the types having a smaller range of supply voltages are suitable for many applications. Their designation is MAA725 H, J or K.

The last type of operational amplifier which has been placed in production for the present is similar to the μA741 integrated circuit and bears the designation MAA741. It belongs to the most widespread operational amplifiers. This product is frequency compensated and has a short-circuit proof output.

For applications in which the internal frequency compensation is disadvantageous, a varian of this operational amplifier has been developed without frequency compensation. This product is known abroad under the designation µA 748, and it is produced at TESLA under the designation MAA748.

The MA3000, MA3005 and MA3006 RF differential amplifiers (similar to the RCA types CA3000, 3005 and 3006) are intended for consumer goods and industrial electronics. The first type is for RF amplifiers up to 30 MHz, modulators, mixers, time-base circuits, direct current amplifiers, comparators, etc. The other two types can be used as RF amplifiers up to 120 MHz with balanced or unbalanced input and output, as wideband or narrow band amplifiers, detectors, mixers, etc.

An additional product which the user quite frequently employs in the field of industrial electronics is the adjustable MAA723 voltage regulator with the subtype MAA723H (similar to the µA 723). This circuit is designed for the stabilizing of input voltages of up to 40 volts. The output voltage can be adjusted in a range of from 2 to 37 volts, and the maximum output current is 150 ma.

Monolithic voltage regulators were developed for a number of applications, in which a higher load current is required, while the output voltage does not have to be adjustable. At the present time, types are being produced for output voltages of 5, 12, 15 and 24 volts under the designations MAA7805, 7812, 7815 and 7824. The maximum output current is 1 a. This series is to be expanded in the future with types for voltages of 6, 8 and 18 volts.

The circuit for phase control of triacs and thyristors with inductive or resistive loads, having the types designation MAA436, is intended for industrial electronics applications.

TESLA is producing a series of integrated circuits for consumer electronics, which are designed for processing both RF and AF signals. The first of them is the MAA661 (similar to the TAA661), which is intended for FM IF amplifiers in television receivers. In addition to the amplifier stages for the FM signal, this circuit contains noise and amplitude limiters, a coincidence detector, a voltage regulator and an AF preamplifier.

The MAA550 temperature compensated voltage regulator for 33 volts for varicaps is also intended for large scale use in consumer goods electronics.

A set of circuits for a color television signal decoder has been developed at TESLA. These circuits can be used for both SECAM and for PAL standards:

MBA540

Control voltage generation for the chrominance type signal, generation of color switching and identification signals, chrominance subcarrier oscillator.

MCA640

PAL/SECAM chrominance type combination, contains a color killer, a 7.8 KHz flipflop, SECAM identification, blanking circuit for the chrominance type signal, enable circuit for the color synchronization signal and internal PAL/SECAM changeover switching.

MCA650

Synchronous detector for PAL and SECAM chrominance signals, PAL matrix to obtain separate (R-Y) and (B-Y) portions of the chrominance signal, PAL switcher for line by line phase rotation of the (R-Y) component, SECAM permutatot and limiter, internal PAL/SECAM changeover switching.

MCA600

Brightness, saturation and contrast setting for the light density signal, black level clamping, inverter amplifier for matrixing the (G-Y) signal from the (R-Y) and (B-Y) chrominance signals; contrast adjustment with three electronic potentiometers.

Besides these four circuits for the chrominance decoders, the MBA530 is being developed at the present time. We are dealing here with a RGB matrix, which generates the signals for the individual colors from the (R-Y), (B-Y) and brightness signals. Furthermore, a group of AF power amplifiers is included in the production assortment.

Of the modern AF Power amplifiers, the MBA810A (similar to the TBA810) with an output power of 5 watts was placed in production as the first of its type. Within the framework for the modernization of this type, the new variants MBA810S, AS were developed for an output power of up to 6 watts with internal protection against thermal overload, and placed in production. In the next step of the modernization of this well proven amplifier, an equivalent type of the TBA810DS and DAS types is being developed. These circuits have built in voltage protection.

TESLA is the first manufacturer in the CEMA member nations to place in production monolithic AF power amplifiers of over 10 watts with the designation MDA2010 and MDA2020 (similar to the TDA2010 and TDA2010 and TDA2020). These circuits are designed as class B operational amplifiers with output power of 10 and 20 watts. In addition to the high output power, they exhibit low distortion and internal thermal, power and current overload cutoff.

An additional integrated circuit which is underdeveloped is of the nature of a high power circuit. It is a vertical sweep stage for a black and

white television receiver. Its designation is MDA1044. It can also be used in color television receivers in conjunction with complementary power transistors and a few discrete components. A variant with the designation MDA1044F is being developed for color television receivers at the same time as this integrated circuit.

2. Logic Integrated Circuits

2.1. Bipolar Circuits

At the present time, the assortment of logic integrated circuits in the CSSR is being based primarily on bipolar technology, however, in line with the present trend, a series of unipolar circuits is being developed. Three independent series of circuits are being produced using bipolar technology in the CSSR.

2.1.1. Integrated TTL Circuits

The largest assortment is being produced in standard logic. The last MSI circuits from the MH74 standard series (similar to the SN74 .... N) are being placed in production this year. Although this series does not contain all types which are needed in the CSSR, it will not be necessary to expand it because, on one hand, an expensive assortment of these circuits is available in the CEMA nations and, on the other hand, the customers are turning to a newer component base.

The following types of logic TTL circuits are found in the production assortment of TESLA at the present time:

MH 7400 Quadruple NAND gates with two inputs each;

MH 7403 Quadruple NAND gates with two inputs each with an open collector;

MH 7404 Sextuple inverter;

MH 7405 Sextuple inverter with open collector;

MH 7410 Triple NAND gate with three inputs each;

MH 7420 Dual NAND gate with four inputs each;

MH 7430 NAND gates with eight inputs;

MH 7437 Quadruple NAND power gates with two inputs each;

MH 7438 Quadruple NAND power gates with two inputs each anddan open collector;

MH 7440 Dual NAND power gates with four inputs each;

MH 7442 BCD Decimal decoder without driver transistors;

MH 7450 AND-OR-INVERT gate with expansion capability through an expander;

MH 7451 Double AND-OR-INVERT gate;

MH 7453 AND-OR-INVERT expansion gate;

MH 7454 AND-OR-INVERT gate;

MH 7560 Dual expander with four inputs each;

MH 7472 J-K master slave flipflop;

MH 7474 Dual D-flipflop;

MH 7475 Quadruple storage flipflop, four bit intermediate store for binary information;

MH 7490 Binary coded count decade, divide by 10, divide by 5;

MH 7493 Four bit dual counter, three bit dual counter;

MH 7496 Five bit register for series-parallel converter, parallel-series converter, memory

MH 74141 BCD decimal decoder and driver with high reverse voltage rated driver transistors for the direct control of digital display tubes;

MH 74150 16 bit data selector/multiplexer;

MH 74151 Eight bit selector/multiplexer;

MH 74154 Four bit binary decoder/demultiplexer with A, B, C and D data selection inputs, gating inputs G1 and G2, and 16 outputs (1 to 16);

MH 74164 Eight bit shift register with series data input, parallel data output, push-pull outputs and asynchronous restoration;

MH 74192 Synchronous decade BCD bidirectional counter with separate clock inputs;

MH 74193 Synchronous dual bidirectional counter with separate clock inputs.

All of the circuits cited here (with the exception of the MH 71414) are also produced in the following series in addition to the MH 74 series (for a temperature range of from 0 to +70° C): the MH 84 series (for a temperature range of -25 to +85° C) and the MH 54 series (for a temperature range of -55 to +125° C).

2.1.2. STTL-FKS

The second series of bipolar circuits is being produced STTL logic. The following assortment is in production: MH 74 S00, MH 74 S03, MH 74 S10, MH 74 S20, MH 74 S64, MH 74 S74 and MH 74 S112.

The circuits with fast STTL-logic with the same numerical designation as the circuits of the TTL standard logic have the same functions. The type MH 74 S64 is an AND-OR-INVERT gate with 4-2-3-2 inputs, the MH 74 S112 is a JK flipflop. All of these circuits are also produced in the MH 84S and MH 54S series. The series cited above will be supplemented in the coming year with an additional four types: Mh 74 S04, MH 74 S37, MH 74 S38 and MH 74 S51.

In the future, these technologies are to be employed only in the case of MSI and LSI circuits. The constitution of the assortment will depend to a certain extent on the requirements of other CEMA member nations. Significant process in the field of bipolar technology is represented by the development of the first MSI circuit based on the low power Schottky TTL technology. Although we are dealing here with a special circuit having limited applications (a decoder driver for the display of a pocket calculator), it is a representative of the new technology which encompasses new technical capabilities.

2.1.3. Slow Interference-Immune Logic

The last series of bipolar logic circuits is characterized by a high degree of interference immunity, and for this reason, is designed for those applications where large interfering signals occur. The following circuits are found in the production assortment:

MZH 115 Quadruple NAND gate with two inputs each;

MZH 145 Dual NAND power gate with five inputs each;

MZH 165 ISL-TTL level converter with open collector;

MZH 185 TTL-LSL level converter;

MZJ 115 JK master-slave flipflop;

MZK 105 Timing circuit;

All of these circuits are equivalent types of the FZ 100 series.

2.1.4. Memories and Microprocessors

In line with the international trend, the development of bipolar circuits with a high degree of integration has started in the CSSR. Within the framework for the development of the technology for these circuits, the circuits for the I 3000 microprocessor system are being developed at the present time. This system was selected on the basis of the need of future customers in the CSSR for a fast bipolar system. Moreover, the MOS system of the type I8080 was required, which has the same bipolar cirucits as the system 3000.

The following circuits are envolved:

MH 3001 Microprogram controller;

MH 3002 Processor element;

MH 3003 Transmission unit;

MH 3205, MH 8205 A 1 of 8 decoder;

MH 3212, MH 8212 Input-output eight bit memory;

MH 3214, MH 8214 Interrupt control;

MH 3126, MH 8216 BUS driver (not inverted);

MH 3226, MH 8226 BUS driver (inverted).

In the field of bipolar memories, the production of RAM stores with a capacity of 64 bits (type MH 7489) was started in the last year. At this time, the development of the electrically programmable ROM memory designated by the MH 74188 with a capacity of 256 bits and the RAM memory with a capacity of 156 bits (MH 74 S201) has been completed. The type MH 74 S201 is then the fist type of memory which is being produced in the Schottky TTL bipolar technology. The programmable memory (PROM) MH 74 S287 with a capacity of 1,024 bits is in preparation.

2.1.5. Contactless Switches

Included in the category of bipolar integrated switches are also the following two contactless switches, which are being produced at TESLA: MH 1 SS1 (magneticly activated contactless switch) and MH 1 ST1 (Schmitt trigger).

Design work has begun in this area on a new type of magnetically activated contactless switch, which is to have a pulse output. The assortment is to be expanded with variants in miniature housings in the next stage.

2.2. MOS Circuits

The monolithic six-channel switch MH 2009 (similar to the MEM 2009) is a simple MOS switching circuit. Furthermore, the production of MNOS switching circuits is being initiated, which are designed for the contactless touch controlled switching (program selection) of the receive channel in television and VHF broadcast receivers. The MAS 560 makes it possible to switch among four channels, and the type MAS 561, among six channels. Plans are being made for the production of the MAS 562 switching circuit, which makes it possible to switch among eight programs.

An ROM memory of 2,560 bits with the designation MHB 2501, which serves as a character generator of latin letters, is in production. The variant of the ROM memory with 2,560 bits, the MHB 2502, has been developed as a character generator for the entire alphabet and all other usual characters. The development of the unipolar decade counter in MNOS technology with an n-type substrate and a p-type channel (MHB 108) and the timing generator MHB 104, is being completed.

Additional types now in production are a static shift register of 1 x 32 bits (MHB 1032, similar to the SS-7-1032), a static shift register of 4 x 32 bits (MHB 4032, similar to the SL-7-4032) and a dynamic shift register of 2 x 100 bits (MHB2100, similar to the DL-7-2100).

The production of the UART (universal asynchronous receiver-transmitter, similar to the AY-5-1012) will be started next year.

Two types of static 1,024 bit RAM memories are underdeveloped, specifically using Si-Gate-n-channel technology (similar to the 1 2102 A) and using CMOS (similar to the SIL 1902A) technology.

3. Summary

The assortment of integrated circuits which has been briefly described in this article is quite extensive. It covers the major portion of the need of CSSR industry. Still, a single manufacturer cannot supply the broad assortment of the most modern integrated circuits such as are required by equipment manufacturers. The only promising solution appears to be efficient specialization and cooperation within the framework of the CEMA.

Good results have been achieved in this area, and further work is being carried out in order to deepen the international socialist division of labor in two or more ways. Many types are exported to other CEMA member nations on the basis of specialization contracts which have been concluded. The products imported within the framework of specialization from other socialist countries supplement and expand the assortment available to Czechoslovakian manufacturers of electronics systems.

It is necessary to work out the technical specifications from the viewpoint of a uniform classification and quality evaluation of the products. In the case of two party negotiations, the products list for the general technical requirements and for the type standards is first worked out and concluded. These technical specifications have been worked out in light of similar authorized documents in the CEMA working organs.

In view of the complexity, which, among other things, is involved with the necessity of equipping test facilities with new test and measurement systems, and in many cases, also the changing of the organization and procedures for testing, the complete solution of this problem will require further efforts from the partners concerned.

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MULTICHIP HYBRID COMPONENT FOR FREQUENCY DIVIDER CIRCUIT

East Berlin RADIO FERNSEHEN ELEKTRONIK in German Vol 28 No 1, Jan 79 pp 19-21

/Article by Dr Manfred Wetzko, Peter Streubel, and Juergen Althus, Dresden Technical University, Department of Electrical and Precision Engineering: "Universal Frequency Dividers in Hybrid Technology"/

/Text/ The following paper describes a frequency divider with an adjustable integer division ratio between 2:1 and 6561:1. The construction of this divider as a multichip hybrid component demonstrates the capabilities of hybrid technology.

Circuit

Figure 1 shows the circuit of the frequency divider. It contains four divider arrangements and a pulse transformer corresponding to the purpose intended. Each divider arrangement consists of two IC's of Type D 195, one rotary switch with nine switching positions, as well as two or respectively three NAND gates D 100. The output frequency of each divider arrangement is always used as the input frequency for the following divider arrangement. The levels tapped by the switches are linked by Gate 1 of IC_{13} ($IC_{13/1}$) to reset the dividers and to control the pulse transformer (IC_{12}, T_1). The division ratio can be selected by means of the switches. It obeys the following formula:

$$T = 1 + S_1 \cdot 9^0 + S_2 \cdot 9^1 + S_3 \cdot 9^2 + S_4 \cdot 9^3 \qquad (1)$$

Here, S is the position of that switch which is identified by the respective index. If all switches are set to zero, the divider is shut off. The maximum divider ratio is

$$T_{max} = 1 + 8 \cdot 1 + 8 \cdot 9 + 8 \cdot 81 + 8 \cdot 729 = 6561.$$

The function of the divider arrangements can be explained by using the first one as an example. Suppose that a division ratio of 9:1 is required. This

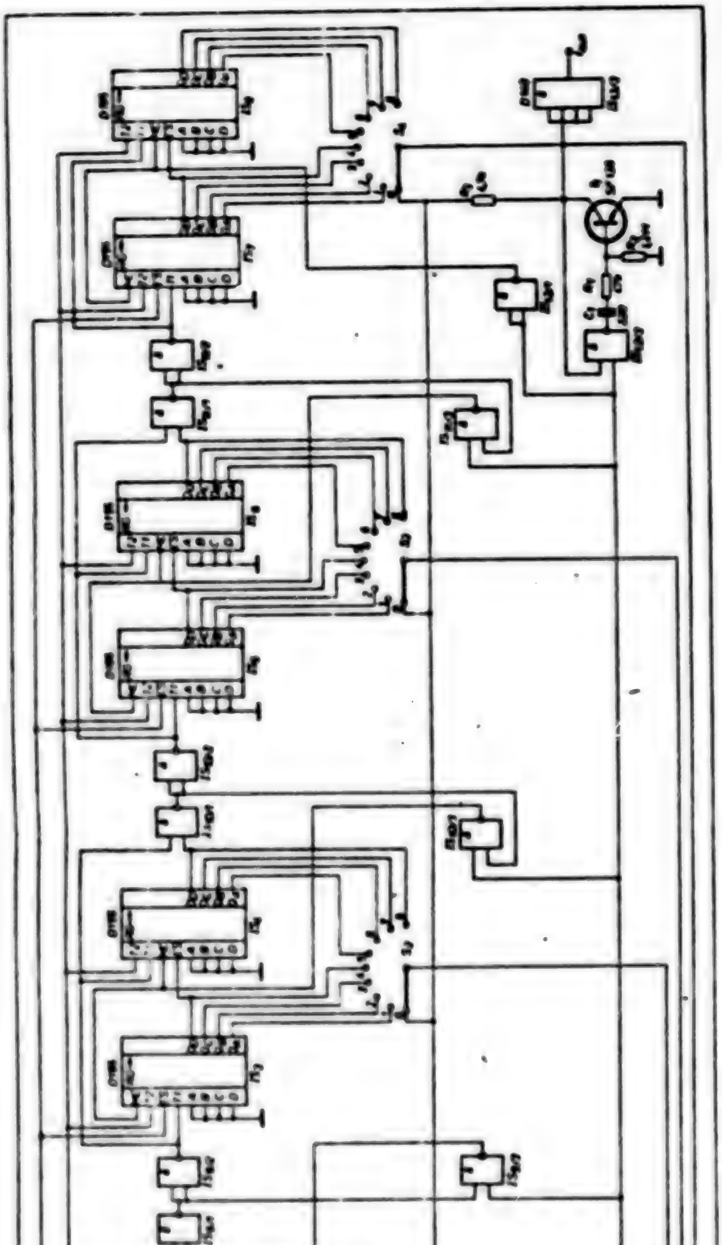

Figure 1: Circuit diagram for the frequency divider

is made possible by the switch positions $S_1 = 8$, $S_2 = S_3 = S_4 = 0$. In the initial state, the outputs Q_A through Q_D of IC_1 and IC_2 are at L. Consequently, the output of Gate 3 of IC_9 ($IC_{9/3}$) is at L. Through the control inputs MC, IC_1 and IC_2 are therefore set to right shift and serial input (1). The data input for serial input is ES. With IC_1, this is always at H. During the right shift, the clock pulse input T1 is effective. With its negative pulse edge, the first clock pulse at T1 sets the output Q_A to H. With each successive clock pulse, this H-level is shifted to the next output. Consequently, after the fourth clock pulse, the H-level is also present at the output Q_D and consequently at the signal input ES of IC_2. Here the process repeats, so that, after the eighth clock pulse, the output Q_D of IC_2 is switched to H. Through Gate 1 and Gate 3 of IC_9, this H switches the control inputs MC to H. IC_1 and IC_2 are thus switched over to parallel input and cycling through T2.

The inputs for parallel input A through D lie at L and become active. The ninth clock pulse enables the L-level to be staticized. Consequently, L is present at all the outputs, and the initial state is reestablished. The following divider arrangements work in the same manner. However, they are controlled at T1 by the reduced clock pulse frequency from the preceding divider arrangements.

The circuit contains a total of 14 semiconductor chips. Eight of these are D 195, one is D 140, four are D 100, and one is SF 136. Five gates of the D 100 chips remain unused. The power consumed is 2.1 Watts. The saving of one D 100 chip was given up, in order to achieve a better circuit design.

Technical Implementation

The circuit described above was implemented as a multichip hybrid component in thick film technology (Figure 2).

Below we shall especially emphasize the technological implementation of this circuit, paying special attention to the utilization of the thick film technique to produce the multi-layer circuit support. Table 1 shows the sequencing scheme, beginning with conversion of the circuit into a topological design, up to testing of the component.

Topological design and fabrication of the originals

The following boundary conditions formed the starting point for working out the topological design:

> Implementing the circuit on a minimal substrate surface (taking into account the standard dimensions of the ceramic substrate)

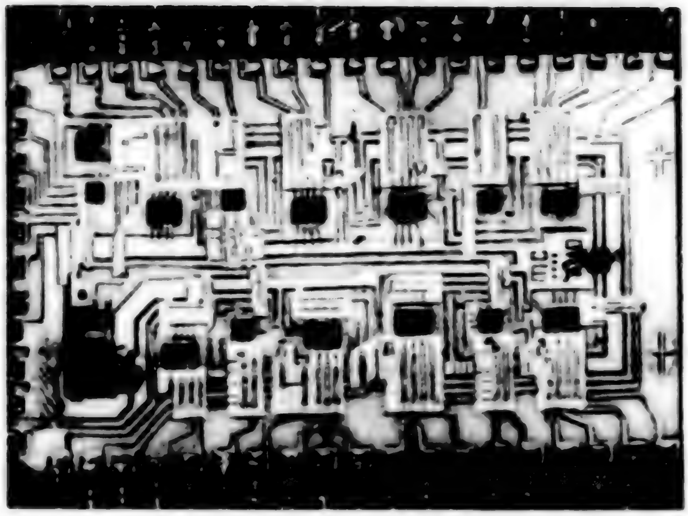

Figure 2: Multichip hybrid component with two-level circuit support in thick film technology

Table 1: Sequencing scheme for technological implementation

Manual topological draft

↓

Production of originals in adhesive technology scale 10:1

↓

Reproduction by means of Reprocamera to scale 10:1
(production of working masks)

↓

Production of emulsion screens by means of photolithography

↓

Production of circuit bodies in thick film technology

↓

Contacting with connecting strips

↓

Inserting the proper hybrid elements (e.g. chip capacitors)

↓

Chip bonds with conducting glue

↓

Bonding the chip connections to the circuit support
by means of ultrasonic bonds with Al wire

↓

Preliminary electrical test

↓

If necessary

Chip replacement

↓

Encapsulation by gluing on a metal cap

↓

Final test

Technological capabilities of thick film-, film-, and thin film-technology, with respect to minimal structural widths, passive components, and conductor crossings

Possibilities for implementation as a single-level variant for film and thin film technology (crossings with bond bridges where appropriate).

The size of the substrate was chosen 30 mm X 50 mm. This was determined by the number of connections required and by adherence to a connecting grid of 2.5 mm. Because of the size of the substrate, however, the unusual three-sided connection arrangement could not be circumvented. This also determined the design as a flat pack component. The actual, relatively large circuit area could be used for a circuit design which guarantees reliable technological implementation as well as favorable electrical properties. The minimum conductor widths and gaps for signal and power supply lines were 0.35 mm.

The design of conducting paths, also called layout, was determined by the arrangement and, in some circumstances, by the rotation of the individual chips (placement). The objectives here are a minimum conductor length and the avoidance of line crossings. Manual design presupposes a certain amount of experience. Computer-assisted methods were partly used, with their resulting saving of time. For implementation as a two-level thick film circuit, the following designs were required:

first circuit level
insulating layer
second circuit level
resistance structure.

These designs were produced by the adhesive technique on a scale of 10:1. They were reduced to the scale 1:1 by means of well-known reproduction methods.

Fabrication of Screens

In order to produce experimental specimens, direct emulsion screens were fabricated in accord with the individual designs. Despite their relatively coarse structures (minimum dimensions 0.35 mm), the bounds of direct emulsion screens, e.g. large boundary roughness of the structures, became visible. This appeared especially in the case of structures which crossed the meshes and when the threads did not run parallel to the structure.

When the structural dimensions are reduced below 0.25 mm, indirect emulsion screens or metal masks must be used.

Production of the Circuit Support in Thick Film Technology

Table 2 shows the sequencing scheme for fabricating the thick film circuit support. A platinum-silver conducting paste was used for the conducting lines. This material is well compatible with the insulation and resistance materials utilized and has a low surface resistance of $R_F = 2...3\ m\Omega/\square$ [1].

Table 2: Sequencing scheme for producing a thick film circuit support

Cleaning the substrate
↓
1st Conducting level
Printing
Drying at 150°C
Burning-in at 850°C
↓
Insulating layers
Printing (first impression)
Drying at 150°C
Printing (second impression)
Drying at 150°C
↓
2nd Conducting level
Printing
Drying at 150°C
↓
Resistances
Printing
Drying at 150°C
↓
Joint burning-in of the insulating layers, of the second conducting level, and of the resistance elements, according to the preferred burning profile, 850°C, 60 minutes

A double impression is recommended to produce the insulating layers. This reduces the probability of needle perforations in the insulating layer, caused by inclusions and screen defects. Reference (2) specifies an intermediate burn after the first impression. The circuit supports were fabricated according to the sequencing scheme shown in Table 2, and they had no

1) Resistance of an arbitrarily large square surface with a dried film thickness of 25 μm.

short circuits because of needle perforations. The paste system utilized makes it possible to burn in simultaneously the insulating layers, the second conducting level and the required resistance prints. In designing the resistance structures, care should be taken that these lie in the first conducting level.

After burning, the finished circuit support is ready for further processing according to the sequencing scheme shown in Table 1. These steps of the process will not be discussed below. A number of special publications (3) to (6) are available on this point. However, we note at this point that chips, which are localized as defective during the preliminary electrical test, can easily be replaced. Consequently, the uncapped componenet can be repaired (8).

The implementation route described in this paper represents only one of many possible solutions.

The packing density and the number of circuit levels could be increased.

Implementation of the circuit described above by means of discrete components would require about six times the area on a two-level printed circuit board.

Heat Studies

A basic problem in implementing highly integrated multichip components is the dissipation of loss power which has been converted into heat. But the practically achievable packing density depends on this factor. Heat problems appear especially when semiconductor chips are used in bipolar technology; with higher degrees of integration, however, even components with unipolar chips must be thermally dimensioned.

The direct correlation between the temperature of the component and its reliability should not remain unmentioned. It was therefore of interest to measure the temperature profile which resulted over the uncapped component. Such a measurement yields direct conclusions concerning optimum thermal dimensioning.

In principle, it is possible to measure the surface temperatures of electronic components by means of special thermocouples (7). A non-contact measurement of the surface temperatures is particularly well suited for determining the temperature profile without feedback. The variable measured in this way is the heat radiation emitted from the object.

With the component under discussion, the emission factors of individual structures (AgPt conductors, Si chips, insulating layers on Al_2O_3 ceramic) were not sufficiently well known. Consequently, the component was coated with black matte lacquer.

A micropyrometer MP-3 was available as a measuring device. This device was especially developed for measuring temperatures at miniature surfaces (measurement area about 50 μm X 50 μm), in particular to determine the temperature profiles of electronic microcircuits.

The multichip component was soldered onto a test printed circuit board - only ten connections were contacted for the experiment. The component was scanned line-by-line (for lines 1 through 27, see Figure 3). The respective thermal profile was recorded with an X-Y recorder (Endim 2000).

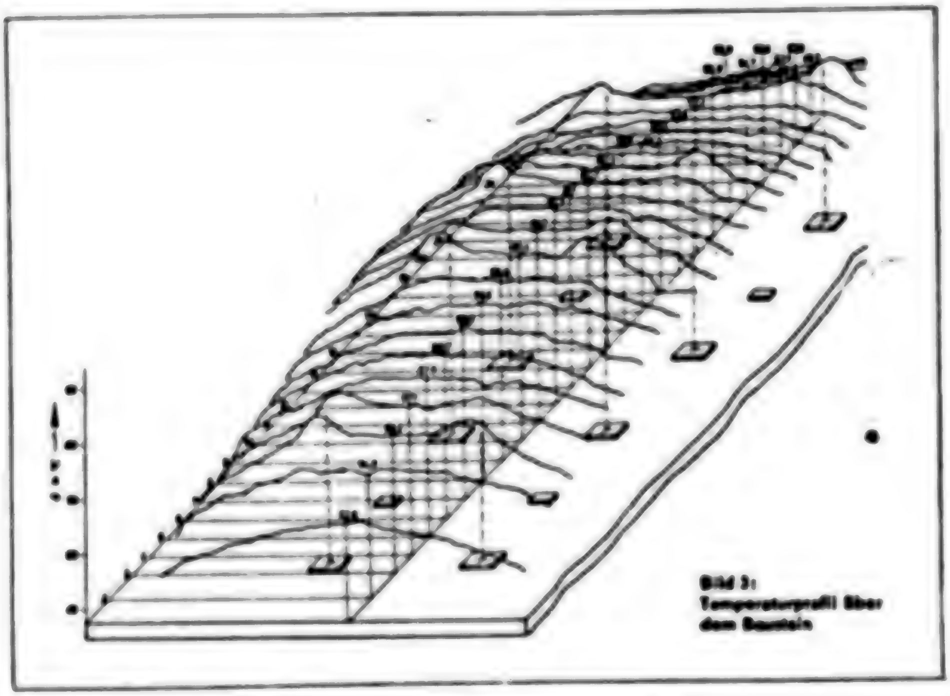

Figure 3: Temperature profile over the component

A black radiation source served to calibrate the micropyrometer. The source temperature was determined with a thermocouple and a compensation strip chart recorder.

All thermal measurements were made in the stationary state. Figure 3 shows the resulting temperature profiles; a three-dimensional representation was chosen for clarity.

The maximum substrate temperature occurs at Point C (61.3°C). The surface temperatures of the MSI chips D 195 lie only 2...3 K above those of the neighboring substrate material. The reasons for this are the relatively low heat transfer resistance (about 15 KW^{-1} with a contact area of 1 mm^2) and the low film thickness (about 10...15 μm) of the metal-filled epoxy resin adhesive that was utilized. Figure 3 simultaneously shows that the D 100 chips caused no measurable effects on the thermal profile of the component.

The temperature gradient towards the edges of the substrate is noteworthy. This indicates the considerable heat conduction from the substrate to the printed circuit board over the ten soldered connections.

The measured profiles indicate the following generally valid conclusions for the thermal dimensioning of highly integrated multichip components:

1. All chips with high loss power must be included in the thermal consideration; chips whose loss power is smaller by orders of magnitude can be neglected.

2. Metal-filled epoxy resin adhesives are suitable for the surface contacts of uncapped chips. This confirms the statements in reference (3).

3. With multichip components, all connections in the grid should be provided with a contacting connection fitting, even when not all the connections are electrically active. This is necessary from the point of view of favorable heat dissipation to the circuit board.

4. With multichip components of the technology under discustion (Al_2O_3 substrate), the maximum loss power that can be dissipated lies in the order of magnitude of 0.2 W/cm^2, unless special measures are provided for heat dissipation.

Summary

The circuit described above has universal application. It is implemented as a hybrid component. It thus indicates several capabilities of this technology, which is especially characterized by the broad spectrum of usable components and by relatively short development times as compared to other technologies.

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DETAILS ON K 1510 MICROCOMPUTER SYSTEM PRESENTED

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[Two-part article by Wolfgang Reimann, VEB Robotron Electronics, Zella-Mehlis: "Microcomputer System K 1510"]

[No 7, Jul 79 pp 421-424]

[Text] The first microcomputer system developed and produced in the GDR was the MRS [microcomputer system] K 1510 of Robotron. It operates on the basis of the microprocessor U 808 D from the VEB Radioworks of Erfurt. In this article, the MRS K 1510 is presented with respect to its construction and its components.

The microcomputer system Robotron K 1510 is a modularly designed system which can be assembled from functionally coordinated structural and operational groups, depending on requirements, into a microcomputer suited to the circumstances of application. An essential criterion in this connection is the free programmability of the semiconductor memory, since the program existing in the memory is the determining element for all sequences of operation in the microcomputer. The control and processing functions are effected in the microcomputer by way of a microprocessor.

The application features of the microcomputer are measurement-data acquisition, measurement-data concentration, and control-value output in connection with subprocesses in hierarchies, autonomous monitoring and control of subprocesses and operating methods, autonomous production-data logging, digital controls, digital regulating of tooling and processing machinery, control of measured-value processing in connection with measuring instruments and test equipment, as well as scientific-technical and economic tasks.

The using of the MRS K 1510 is characterized by high reliability, small energy consumption, good integrability through the structural designing of the receptacles in accordance with EGS [expansion unknown] and

IEC [International Electrotechnical Commission] standards, and by easy adaptation to differing application tasks.

Construction

The microcomputer system consists of components of equipment technology and systems documentation. Belonging to equipment technology are structural and functional groups, among which are printed circuit boards, receptacle devices, current-supply modules, cables, and so forth.

The functional units are housed in separate plug-in units and can, with few exceptions, be inserted at any plug-in positions in a microcomputer bus.

The use of the mechanical components is assisted by a series of systems documentations. They serve for program development and testing by the user in connection with the utilization of host computer systems, as well as for the operating of microcomputer-controlled devices and equipment.

Employed in the MRS K 1510 are plug-in units and current-supply modules having the dimensions of 135 mm X 170 mm. The plug-in units are provided on one side with a 90-channel direct plug-type connector, and in the case of interface plug-in units they are provided on the opposite side (handle side) with a maximum of two 39-channel, indirect socket boards. The connecting of the peripheral units is made via these. An addressing array on the plug-in units of the memory and device-interface controllers makes possible an address and interrupt allocation.

Serving for the housing of the plug-in units and current-supply modules as the smallest receptacle unit are the subassembly racks (BGS) (Figure 1 and Figure 2). The subassemblies for plug-in units and current-supply modules are different in construction.

The BGS for the housing of the plug-in units consists of a receptacle which is provided with a circuit wiring frame. The wiring of the plug-in units takes place through a printed, rigid return-wiring circuit board (also called an MR bus). The return-wiring printed circuit board or backplane is a two-plane circuit board which brings 90 parallel leads to always the same contact positions of plug-type connectors. The modular dimension of the plug-in units amounts to 20 mm, so that a maximum of 20 plug-in units can be accommodated on the MR bus.

The current supply of the K 1510 is assembled from a series of existing current-supply modules, depending on the insertion of the subassembly frame K 0116 or K 0115 by the manufacturer.

Depending on the voltage and current requirements, 20-watt and 50-watt current-supply modules can be used. Here it should be noted that these cannot be connected in parallel. Given several current-supply modules of the same voltage, these must be assigned to specific plug-position areas.

In a subassembly rack K 0118 having a width of 480 mm, there can be inserted--aside from the hum eliminator--seven current-supply modules of the 20-watt series or fiv current-supply modules of the 20-W series and two current-supply modules of the 50-W series (Figure 3). In Table 1, all the current-supply modules are listed. The current-supply modules--which are also in keen demand as solo subassemblies, since they operate autonomously and do not need auxiliary voltages or auxiliary equipment of any sort--are protected on the output side from overvoltages as well as excess currents.

On a 20-W current-supply module, a current-supply attachment K 0312.03 or K 0312.04 can be connected. It generates from an a.c. voltage provided by the current-supply module a regulated direct voltage of low power (Figure 4).

If the subassembly racks for plug-in units and the current-supply modules are structurally connected with one another, then one obtains a subassembly unit (BGH K 0111 or K 0112--see initial picture at the beginning of this article).

In a BGH there exist for the user 14 freely available plug-in locations for storage and device-interface controllers. Six other plug-in locations are needed for the central processing unit, the central processing unit attachment, and for the device-interface controller of the operator's unit.

These subassembly racks, which are arranged one behind the other, can also be mounted over one another. This structural configuration is an additional sales design, and a subsequent conversion is not possible.

If the 14 plug-in locations of a BGH are not sufficient, a second BGH can be positioned over the first. With this double subassembly unit, one has then reached the maximum design capabilities of the MR K 1510. Here also, control is effected through only one central processing unit. The connecting of the two backplanes is made by way of a bus extension lead (BUW K 4110).

Table 2 shows a summary of the systems used.

Structural and Functional Groups

All the structural and functional groups of the microcomputer system K 1510 are listed together in the systems summary (see Figure 5 and Table 3), except for the cables and servicing equipment.

Central Processing Unit K 2511

The central processing unit (ZVE) coordinates the control sequence of the microcomputer and operates with the use of the microprocessor U 808 D of the VEB Radioworks of Erfurt.

With a processing width of 8 bits (1 byte) and a base instruction sentence of 48 commands--which can be expanded through their application to the various registers, gates, and conditional flip-flops to an instruction sentence of 226 commands dissimilar in their effects--the microprocessor organizes information processing and data exchange according to a predetermined program which has been written in the memory of the microcomputer. The microprocessor provides the direct memory addressing of 16 K bytes.

As can be seen from the systems summary in Figure 5, the ZVE divides the microcomputer bus which permits data exchange between the ZVE and the memories, the device-interface controllers, and the specific logic subassemblies.

The ZVE is housed in two plug-in units which are designated ZVE control and ZVE mainframe. The essential functional groups of the ZVE mainframe (STE 051-8460) are

Clock generator	Receiver register
Microprocessor	Control (sorting)
Matching circuit	

and those of the ZVE control (STE 051-8470) are

Decoder	Address extension
Command decoder	Interrupt handling
Control	

The disconnect of the bus is the plug-in unit position 6, which must be attached to the ZVE control, since most of the bus leads are operated from this control.

The ZVE mainframe can be plugged in at any location on the short bus (plug-in unit positions 1 to 5).

ZVE Attachment K 2011

The ZVE attachment (ZVZ) consists of a plug-in unit and likewise occupies a plug-in position on the short bus. The ZVZ has the function of extending the existing interrupt organization of the ZVE by means of a separate pushdown stack, which can effect--aside from automatic recovery of the program counter with interrupt--also the program-controlled recovery of the universal register and of the conditional bit. By this means the internal stack storage of the ZVE becomes free and can be used for the setting up of subroutine jumps.

The pushdown stack operates according to the LIFO principle (last in-first out), and a maximum of 32 characters can be stored. An overflow check does not occur.

The setting up of an interrupt command upon recognition of an interrupt takes place in the interrupt-command load area. The command generation takes place with the help of a storage switching circuit (PROM) [programmable read-only memory] which is housed in the ZVE.

Since interrupt handling with a ZVE requires a different type of command, there exist two PROMs. According to the desired configuration of the microcomputer, in the manufacturing stage the insertion of the corresponding storage switching circuit is made.

With the use of the ZVE, the interrupt planes decrease from eight to six.

Device-interface Controller for the Operator's Unit K 7012 and Operator's Unit K 7612

The operator's unit (see Figure 6) is a device-specific component which is connected by way of the operator's-unit device-interface controller with the microcomputer bus.

The operator's unit is not required for the operation of the microcomputer, but it serves to assist communication with the microcomputer in start-up, troubleshooting, and in the testing of systems programs.

The operator's unit, by way of a keyboard and display panel, permits:

--the starting of the computer at any given addresses

--the stopping of the computer at any given times and at preselectable program-counter counts (test points)

--direct access to storage

--the displaying of commands, data, addresses, statuses, and loops

--program branches.

The coupling of the BDE with the ABD is made via two cables which are 3 meters long.

Read-only Memory K 3810

The read-only memory serves as the program storage of the microcomputer for non-variable data, and it is freely programmable. For each plug-in unit, a maximum of 4 K bytes can be stored, and building down to 2 K bytes is also possible.

The read-only memory is delivered by the manufacturer in the erased state, and the information to be stored is first determined by the user.

The impressing of the information in the storage circuits takes place with the aid of a programming accessory unit or other programming devices. The storage circuits are therefore inserted into plug-socket holders on the plug-in units so that the inscribing and erasing can be made.

The programming of a PROM is done in one program run and lasts--depending on the program--some 30-200 seconds with the use of the programming accessory unit. The information to be programmed has to be made available in the storage of the microcomputer, and it can be entered in by way of the LBL, TAS, FSM [sic: given in Table 3 as FMS], BDE, or by a duplicate PROM of the PRZ. For a duplicate PROM, the PRZ has available to it a special PROM plug-in location.

If the storage circuits are inscribed with other programming devices, then first of all there must be on hand a punched tape in the code of the programming device.

The erasing of the storage circuits takes place through UV [ultraviolet] radiation. The erasing unit of the PRZ makes possible the erasing of five inscribed PROMs, which are thereupon available for new programming.

In the K 1510, up to three PFS plug-in units can be employed, and the further addressing space of 4 K bytes is reserved for the use of the operational memory.

Operational Memory K 3510 (OPS) and K 3512 (OSS)

The operational memory is a read-write memory and serves to store all variable data during the program execution. The read-write memories are based on the principle of static RAMs [random-access memories], and depending on the type they permit the storage of a maximum of 0.75 K bytes in the case of the K 3510 and 4 K bytes for the K 3512. The building down of the OPS takes place in steps of 0.25 K bytes and that of the OSS in such steps of 1 K bytes.

From 1979 on, only the OSS is still being used. The price-performance ratio is thereby improved, especially in such cases of application for which a large portion of operational memories is required. Furthermore, it brings the advantage that in the case of mains power-supply failures via the accumulator module, the data can be preserved for a certain time (< 3 hours). The time of the data preservation is determined by the size of the operational memory. The maximum storage capacity amounts to 12 K bytes.

Device-interface Controller for SIF 1000 K 6010

The plug-in unit ADA has two channels (an output and an input channel) and serves to connect devices with the standard interface 1000/1. Having

such an interface are the following:

Punched-tape reader 1210-0333
Punched-tape punch 1215-1001
Serial printer 1156
Magnetic-tape cartridge unit 1250/1.

The ADA permits data transmission rates of up to 1,000 characters/sec. It should be noted that the input and output channels can be operated only separately.

Device-interface Controller for Column Printer K 6011

The ASD provides the device-specific interface for the column printer 1154, type 454. With this we have an alphanumeric matrix column printer with a continuous printing rate of 45 characters/sec. The characters to be printed are generated with the aid of a column grid from seven vertically arranged printing pins. The printing of the characters takes place only in the feed-foreward direction.

Device-interface Controller for Teleprinter K 8510

By means of the AFM, a teleprinter for control and printout is adapted to the K 1510. The AFM effects on the output side a parallel-series conversion and on the input side a series-parallel conversion, with a serial modulation rate of 50 bauds. Duplex operation or half-duplex operation are alternatively possible.

Device-interface Controller for Block Printing Unit K 6012

The ABW serves the purpose of coupling and energizing the block printing unit 1132. It is a numeric tape printer with a printing width of 18 characters/line.

The editing of the 18 characters takes place by means of programs. The characters are transferred in an 8-bit special code to the ABW and are there stored. The transmission from the ABW to the BDW is made in a 20-bit special code. The connecting cables are 2.5 meters long.

The ABW consists of two plug-in units, one for the logic and one for the power electronics.

Real-time Clock K 2012

The real-time clock is a logic based on binary and decadic counters, which can be used for the control of user programs in a system using the K 1510. It generates interrupt points with a high precision, in connection with which the pulse interval is selectable.

The fundamental pulse grids are generated from the computer fundamental cycle (480 kHz): 1,000 Hz, 100 Hz, 10 Hz, and 1 Hz. According to the choice of the fundamental pulse, other step-down ratios for the generation of up to three interrups are then possible. The pulse grid for interrupt generation is 1; 2; 4; 8; 16; 32; 64; and 128 msec as well as their 10^1, 10^2, and 10^3 multiples.

Device-interface Controller for V 24 K 8511

In association with the corresponding software, the ASV provides on the K 1510 the logical and electrical connection conditions for the V-24 interface in accordance with the CCITT [International Consultative Commission for Telephone and Telegraph] recommendation V 24 (TGL [GDR norm] 29 077). The device-interface controller operates in a half-duplex manner on the forward channel, and the data transmission takes place asynchronously and serially by bit.

The transmission speed of 50 to 9,600 bauds is regulated by bridges in the ASV.

If the distance between the data terminals is greater than 15 meters, then modems should be interconnected.

The ASV consists of three plug-in units, with the third plug-in unit determining the ASV type. The following modifications are possible:

ASV remote connection K 8511.01

This device-interface controller is required when modems have to be connected into the system.

ASV local connection K 8511.02

This device-interface controller serves to effect direct coupling to the minicomputers KRS 4200, PRS 4000, and to the microcomputer K 1510. If microcomputers are connected to one another, care must be taken that the remote interface is the ASV K 8511.01.

Device-interface Controller for 20-mA Current Loop K 8512.01

This device-interface controller is constructed from the ASV plug-in units 051-8540 and 051-8550 plus another plug-in unit K 8512.02 (current connection attachment). It enables the coupling of the microcomputer with the line concentrator LK 4221 and the coupling of microcomputers with one another up to a terminal separation of 500 meters.

[No 8, Aug 79 pp 491-494]

[Text] Device-interface Controller Sl 1.2 Input K 9210 and Device-interface Controller Sl 1.2 Output K 9211

These device-interface controllers on the K 1510 provide the logical and electrical conditions for a standard interface for linked communication Sl 1.2 in accordance with TGL 29 248, separately for input and output. This connection exists predominantly for laboratory and measurement devices and for those kinds of equipment which process in parallel with one another large amounts of information.

However, these device-interface controllers can also be used for digital-value input and output without the logic conditions of the Sl 1.2. The content of the input lines is then automatically overwritten approximately every 2 μsec into the receiving buffer of the ASI-E [ASI-input]. The receiving buffer is inhibited as soon as the microcomputer interrogates the data. In the case of the ASI-A [ASI-output], at every moment any given bytes at the output lines can be changed by the program. The regulating of the mode of operation is done by an instruction at the beginning of the program run. The input width amounts to a maximum of 56 bits, which can be accepted and buffered in parallel in the receiving buffer. The interrogating of the receiving buffer is done bytewise by the program. The output width amounts to 48 bits. The output into the output buffer takes place bytewise and then out from the output buffer in parallel at 48 bits. The filling of the output buffer can be made programatically in any sequence.

The output lines can be loaded with 10 load units. The transmission distance for both device-interface controllers amounts to a maximum of 20 meters.

Digital Input K 9212

The modules of the digital input permit the input of digital static TTL [transistor-transistor logic] signals or contact signals against logic null. The input of contact signals can be made either with or without potential separation, according to one's choice.

For the digital input, two module versions are made available:

K 9212.01 (STE 051-8440) for the static input of a maximum of 16 TTL signals or 16 contact signals.

K 9212.02 (STE 051-8440 + 051-8360) for the potential-separated input of a maximum of 16 signals (Figure 7).

The input takes place without buffering, and the static input data are filtered for the suppression of interference pulses. The integration time amounts to about 2 msec.

The required minimal pulse duration of the input signals is about 10 msec, disregarding special program requirements. The input can be made cyclically through a computer call-in or through a program interrupt signal which is formed from the modification of an input signal. With this DEI there is an input signal present if the input line has an L-level.

The derivation of program interrupt signals takes place through a comparison of the last accepted with the fed-in information. For every individual bit, the choice can be made through a wirewrap system on the STE 051-8440 whether the leading and/or the trailing edges of the input signal are to lead to the program interrupt. If no wirewrap system is present, then no program interrupt derivation is made.

All 32 possible program interrupt signals are grouped on the plug-in unit into a common interrupt, which can be placed on a corresponding interrupt plane of the microcomputer. By means of an input instruction, this common interrupt can be tested. A masking is possible. The input signal whose modification led to the interrupt must not be changed for the reading in of the corresponding byte. The reading in of the information takes place bytewise through two input instructions. With the reading in of the second byte, at the same time the interrupt request is reset in the DEI.

The maximum length of the power cords is determined by the permissible line resistance. For the TTL input, this amounts to a maximum of 15 Ω and for the contact input to a maximum of 50 Ω.

The delivery of the input signals for the DEI K 9212.01 can be done via either the jack X1 or X2 of the plug-in unit 051-8360.

The driving of the relays takes place by means of 24-volt direct voltage. The make contacts of the relays are laid down in a double-pole configuration on the socket board X1 of the plug-in unit 051-8360, and they are led by way of a connecting cable to the jack X1 of the plug-in unit 051-8440. At jack X2 of the plug-in unit 051-8440, the input ends not energized via X1 can be used for TTL or contact input.

Digital Output K 9213

The digital output modules make possible the outputting of a maximum of 16 digital signals, without interface control by the K 1510, to the connected peripheral equipment.

The output of the 16 signals can be made either in the potential-separated mode or by means of TTL levels, according to the type of the DAR module. The following variants are made available:

K 9213.01 (STE 051-8430) for potential-separated output

K 9213.02 (STE 051-8431) for the outputting of a maximum of 16 TTL signals.

The potential separation in the DAR K 9213.01 is effected by means of dry-reed contact relays with make contacts, and with the contact pairs being led to the contact board X2. The turn-on voltage is applied by the user of the K 1510.

Current-carrying capacity of the signal lines:

Constant current	$\leq$ 1 A
Turn-on current	$\leq$ 0.5 A
Turn-on voltage	$\leq$ 150 V; 50 Hz; $\leq$ 110 V d.c. voltage
Switching capacity	$\leq$ 30 VA (a.c. voltage)
	$\leq$ 12 W (d.c. voltage)

The data take-over of the K 1510 bus is made bytewise and synchronized. The output data are stored in an overwritable output buffer, where the last outputted information is always present at the output end of the register.

For checking the output data, the information being fed in parallel to the contact board X1 can be used. The TTL level can be loaded with a load unit.

Device-interface Controller for Video Display Unit K 7010

The video display unit (Figure 8) is an alphanumeric indicator device having a picture size of 110 mm X 246 mm, which is connected to the microcomputer bus via the device-specific device-interface controller for the video display unit. Some 256 characters from a character set of 64 characters can be represented on the display screen, in 8 lines of 32 characters each. The character representation is made in a (5 X 7) point matrix with a character size of 5.5 mm X 7.8 mm. In this connection, the video display unit K 7210 serves for the representation of latin letters, and the K 7211 for the representation of cyrillic letters.

The operating of the video display unit is program-controlled. Since only the bits 0 to 5 are necessary for character representation, a special function can be assigned to the bits 6 and 7. With bit 6, access to the character store of the BSE can be blocked; the addressed item retains its information if bit 6 = H. With bit 7 = H, a mark is put on the display screen. For underlining discrimination, the mark skips up and down by one line.

The erasing of the display screen is done by means of writing blanks at every entry.

Only one video display unit can be connected to the K 1510, and the connection distance amounts to 5 meters.

The video display unit has the dimensions of 265 mm X 340 mm X 380 mm, and it has a weight of 13 kilograms.

Device-interface Controller for Keyboard K 7011

The keyboard (Figure 9) is supplied as an independent component in its own receptacle, and it is connected via appropriate cables with the keyboard interface controller.

The keyboard can be built down with respect to the function-numeric keyboard (FNT), so that the following keyboard variants arise:

Latin keyboard ANT/FNT K 7610
Latin keyboard ANT K 7611
Cyrillic keyboard ANT/FNT K 7613
Cyrillic keyboard ANT K 7614

The alphanumeric keyboard ANT is designed similar to a typewriter keyboard, and it permits the inputting of letters, numbers, and special characters into the K 1510. A distinction is made between capital and small letters by means of the keys UC (upper case) and LC (lower case). By means of the key OC (other case, other condition), one has the option of switching over--as long as this key is actuated--into another state from that determined by UC or LC. When the key CTRL (control) is simultaneously actuated with certain letter keys, these keys provide control characters in the ISO [International Organization for Standardization] 7-bit code.

The ANT has 65 keys, which are interrogated cyclically and automatically by the ATA, and when there exists a key actuation, characters are generated according to the 7-bit code, based on TGL 23 207. Of these 65 keys, some 60 keys have a fixed symbolism (49 for letters, numbers, and special characters, and 11 control characters). The remaining five keys are freely selectable and can for example be assigned to special functions.

The fixed control functions generate a 8-bit special code. Six keys have been labeled with arrows, and depending on the program they serve as cursor control keys for the video display unit or as format effector keys for a printer or teleprinter.

The functional numeric keyboard FNT has 34 keys, which at actuation generate an 8-bit special code and which are freely available for programming. Some 16 keys of this keyboard can above all be used as a

decimal keyboard for numeric inputs. There are 14 keys which are each associated spatially with a light-emitting diode, but these are electrically separate, so that an independent employability of the displays is possible.

The operating of the keyboard can be done in the roll-over working mode. Through an analysis of the first-pressed key, protection against an erroneous input through the simultaneous operation of several keys is provided for. For one interrogation cycle, 534 µsec are necessary.

The maximum permissible cable length between the keyboard and the device-interface controller amounts to 3 meters.

Device-interface Controller for Keyboard K 7013

With this keyboard interface controller, the user is given the opportunity to connect up to the K 1510 various keyboards which have been built and designed by him. The ATA effects the connecting of two (5 X 8) matrices, which can be united into one (10 X 8) matrix. With that, a maximum of 80 keys can be connected up.

Device-interface Controller for Programming Attachment

This device-interface controller is a component part of the programming attachment (PRZ) K 0410 shown in Figure 10, and thus it is not given a designation of its own. The programming attachment is a desk instrument which is provided for the purpose of electrical programming of PROMs and ERPROMs (and also, for example, for the programming of the U 551 D). The programming is program-controlled by the microcomputer, and the information must accordingly be supplied to the memory of the K 1510. This information can be read in by a punched-tape reader, keyboard, teleprinter, operator's unit, or by a duplicate PROM of the programming attachment. For the duplicate PROM, the PRZ has a specific PROM plug-in location.

The storage capacity of a PROM amounts to 256 bytes, which can be recorded in one program run. The programming time amounts to somewhere between 30 seconds and 3.5 minutes. An erasing device in the PRZ permits the erasing of written ERPROMs, which are thereupon available for new programming. The erasing with UV radiation can be done for five components at the same time. The erasure duration amounts to about 5 minutes and takes place independently of the electrical programming process.

Device-interface Controller for SIF 1000 F K 4510

The device-interface controller for the standard interface 1000 consists of two plug-in units and serves the purpose of coupling devices having the standard interface SIF 1000 F (for example, devices of the data acquisition system 1600). Furthermore, in connection with a feeding in

of U_1 = - 27 V, this device-interface controller allows a hooking up of the microcomputer with a KRS 4200 via the AS 2h.

Operation with the ASF requires in every case a control program, which can be operated with or without interrupt. The maximum connection separation is 20 meters, and the interface has a KME-20 level.

Testing System

For the testing of the microcomputer K 1510 for serviceability, testing equipment is provided by the manufacturer which also allows the user to carry out on his own responsibility the after-sales servicing. The tests proceed in a program-controlled manner, and they are made in association with short-circuit operation or even in conjunction with the connected peripheral devices.

The tests made in short-circuit operation require in addition to the test programs also the corresponding testing equipment, such as short-circuiting plugs, short-circuiting cables, and remote interfaces.

The testing-system descriptive materials (PSU) essentially contain--aside from the description of the programs (in the operational documentation for the K 1510)--the individual programs for all the components of the microcomputer system.

Through the use of an executive program, it is possible to employ a tailored total program for a certain microcomputer configuration. The maximum modification of the total program is required in carrying out the servicing, in order to be able to test each microcomputer configuration.

The dealer offers three formats for providing the test programs:

1. Machine-code punched tape for carrying out individual tests without an executive program.

2. Control tapes in the programming code for the programming of PROMs to carry out individual tests or test sequences according to a project-dependent executive program.

The test programs are generated by the manufacturer in accordance with the MR configuration, so that only a minimum of test-PROM plug-in units are necessary (packed version).

3. Control tapes in the programming code for making PROMs to carry out individual tests or test sequences according to an executive program, without a previous consideration of the MR configuration and address allocation. These test programs have fixed location numbers, and the desired program work-through sequence is read in by way of the operator's unit. For departures from device and interrupt addresses, corresponding generations are to be made by the operator in the executive program (unpacked version).

Table 4 contains all the test programs, and it can be employed by the user as a basis for ordering them.

As for the testing equipment, these devices are in some cases conventional components which are required in microcomputer use, but secondly there are also components or cables which are applicable only to testing purposes.

Within the framework of microcomputer development, special testing devices have been created.

Operator's Unit K 7612

This BDE component was already described; it is absolutely necessary for the working through of the test programs.

Test Adapter K 0410

The test adapter (PRA) is a plug-in unit which was produced specifically for indicating and tracking bus signals. The displays (13 LED's [light-emitting diodes]) are located on the handle side of the plug-in unit and they are needed for address testing, interrupt tests, and E/A [input/output] tests. The test adapter has a fixed address which cannot be changed.

Plug-in Unit Adapter K 0402

The plug-in unit adapter (STA) serves to effect the adapting of plug-in units--an adaptation which can be required for the purposes of troubleshooting.

Adapter Cable K 0510.09

The adapter cable (KAB) is wired 1:1 and serves the purpose of cable lengthening. This is necessary, for example, if the device-interface controller consists of several plug-in units and one of them is to be adapted.

Linkage Adapter K 0404

The linkage adapter (VKA) serves the purpose of checking the device-interface controllers ASD K 6011 and ABW K 6012, since a short-circuit testing by way of a direct feedback of the output lines is not possible on the input leads. The VKA allows the program-controlled simulation of the two printing units BDW 1132 and SD 1154.

Short-circuit Plugs, Short-circuit Cables K 0510.xx

The type and usage of these short-circuit plugs and short-circuit cables (KAB) are shown in Table 5.

Basic Systems Documents

The basic systems documents (SUL) are program routines which provide the prerequisites for the operation of the microcomputer and which also provide the frequently needed basic functions. They are supplied as self-contained programs or also in some cases as subroutines, and they are integrated into tne user program in accordance with the tasks to be solved. The providing of the basic systems documents is done alternatively in the source code, in the machine code, or in the program code 1902.

The basic systems documents include:

Basic edit programs

Assembler	BASS
Loader	BLAD
Punched-tape edit program	BLAP
Test program	BTES

Subroutines for operating of devices

These subroutines are independent program modules which the user can call upon as occasion demands from his user program. Every subroutine provides for the operating of a device-interface controller.

Basic subroutines

In the basic subroutines, we are dealing with mathematical subroutines. In detail, these involve:

Floating-point arithmetic
Floating-point basic functions
Floating-point output conversion
Floating-point input conversion
Fixed-point arithmetic
Fixed-point basic functions
Fixed-point input conversion
Fixed-point output conversion
Conversion programs (standard floating-point ↔ standard fixed-point)
Operating element PBT 4000.

Program Construction

For the making of application programs, the user has the choice of two development routes, according to preference:

1. Program development with a host computer system (KRS 4200, PRS 4000, ESER)

2. Program development with programming console (PAPL K 1510).

The decision of the user will be determined essentially by his access to host computers. On account of their extensive peripheral devices and existing systems documents, the utilization of host computers makes possible a more rapid and more convenient program development than can be done with programming consoles (development systems).

However, working with host computers has the disadvantage that the program development cannot be done under real-time conditions--something which is essential in many cases of application of microcomputer technology. The making of microcomputer programs on host computer systems presupposes that these are necessarily also equipped with the appropriate host-computer software (cross-software).

The following cross-programs are offered by the VEB Robotron Center for Research and Technology of Dresden:

Cross-assembler	CRAS 4000 - K 1510
	CRAS 4200 - K 1510
	CRAS ESER - K 1510
Cross-simulation and Test System	CRST 4000 - K 1510
	CRST 4200 - K 1510
	CRST ESER - K 1510
Cross-editing system R 4200, magnetic-tape oriented	CRAM 4200 - K 1510

The second route for program construction will be the expedient choice for those users who do not have a host computer to use. In this case, use is made of the programming console K 1510, since the expenditure for hardware is very small in comparison to host computer systems. The programming console is a well-developed microcomputer system and it is equipped with a complex-basis MOS (metal-oxide semiconductor).

The essential advantage of the programming console is that the program development can be made on the original peripherals and under real-time conditions.

Terminal Devices as Examples of Application for Microcomputers

The following terminal devices, into which the microcomputer K 1510 is integrated, are available from VEB Robotron:

Programmable Video Display Terminal	PBT 4000
Programming Console	PAPL K 1510
Terminal (DST) in the data-gathering system	DSS 4230
Concentrator (KON) in the data-gathering system	DSS 4230

Aside from the PBT 4000, these terminal devices have a fixed configuration with a device-specific control program. Within certain limits, the video display terminal 4000 can be built up with other components from the microcomputer system, but it then needs a new control program which must be created by the user.

Marketing and Servicing

The marketing of the microcomputer system K 1510 and the terminal devices PBT 4000 and PAPL K 1510, as well as of the attachable peripheral devices, is done by way of the VEB Robotron Sales Department of Berlin.

The undertaking of customer services is made by the technical after-sales services of the individual Robotron sales departments VEB of the GDR. However, an effort is made to have the user help in assuming responsibility for the care of the microcomputers in relation to his final products.

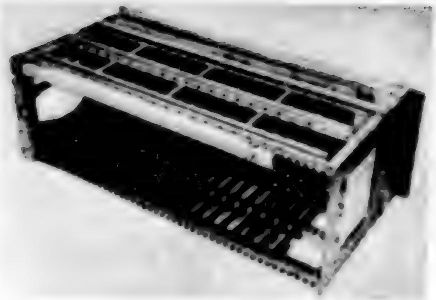


Figure 1: Subassembly Rack K 0116 (K 0115) for the Housing of Plug-in Units

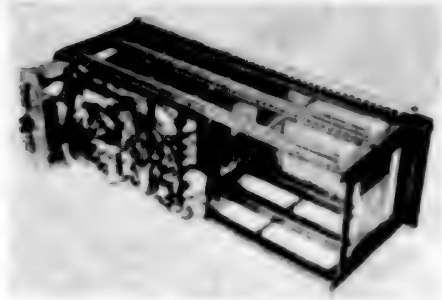


Figure 3: Subassembly Rack K 0118 (K 0117) for Housing the Current-supply Modules

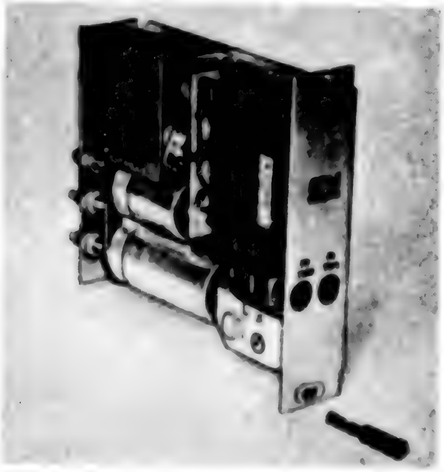
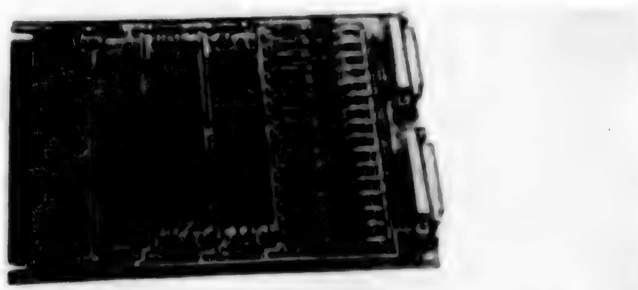


Figure 4: Current-supply Module



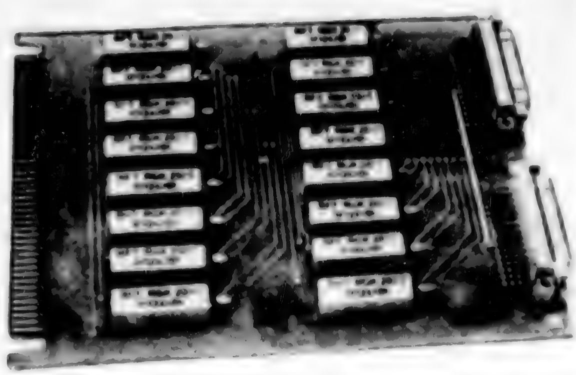


Figure 7: Digital Input Module K 9212.02

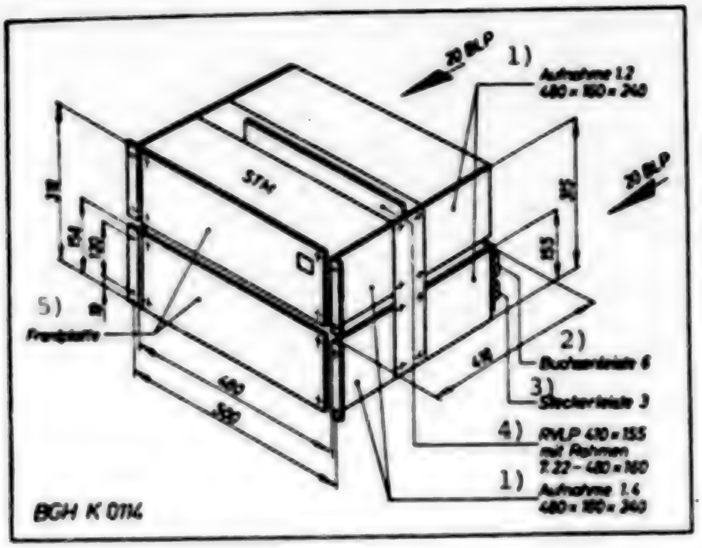


Figure 2: Dimensional Sketch of the Subassembly Unit K 0116

Key:
1. Receptacle
2. Socket board
3. Plug board
4. Return-wiring circuit board 410 x 155 with frame
5. Front panel

Table 1: Current-supply Modules

Tafel 1: Stromversorgungsmoduln

1) Chiffre	U_V/I_A
K 0310.01	12 1,5
K 0310.03	10,7 2
K 0310.04	9 2,2
K 0310.05	5 3,3
K 0310.06	5 10
K 0310.08	9 5,6
K 0310.09	12 4,2
K 0310.10	15 3,3
K 0310.11	6 2,9
K 0310.12	15 1
K 0312.01	60 0,08
K 0312.02	2 × 60 2 × 0,08
K 0312.03	12 0,1
K 0312.04	2 × 12 2 × 0,1
K 0312.05	60, 12 0,08; 0,1
K 0316.01	24 2
K 0316.02	24 2,2
K 0316.03	2 × 24 1,6
K 0316.04	24 3 (Impulsgleichstrom) 2)
K 0311	Netzfilter 3)
K 0315	Akkumulator-Modul für Speicherdatenerhalt 4)

(key on next page)

Key to Table 1:
1. Code
2. Pulsed running current
3. Hum eliminator
4. Accumulator module for storage data saving

Table 2: Summary of Receptacles

Designation	Width	
	450 mm	440 mm
Single subassembly unit (BGH)	K 0211	K 0111
Double subassembly unit (BGH)	K 0114	K 0113
Subassembly rack for STE [plug-in units] (BGS)	K 0116	K 0115
Subassembly rack for STM [current-supply modules] (BGS)	K 0118	K 0117

Table 3: Meaning of the Abbreviations in Figure 5

ABD Device-interface controller for operator's unit
ABS Device-interface controller for video display unit
ABW Device-interface controller for block printing unit
ADA Device-interface controller for SIF 1000
AFM Device-interface controller for teleprinter
APS Automatic production control
APZ Device-interface controller for programming attachment
ASD Device-interface controller for column printer
ASF Device-interface controller for SIF 1000 F
ASI Device-interface controller for S1 1.2
ASS Device-interface controller for current loop 20 mA
ASV Device interface controller for V 24 (S2)
ATA Device-interface controller for keyboard
BDE Operator's unit
BDW Block printing unit 1132
BSE Video display unit
DAR Digital output module
DEI Digital input module
DES Data acquisition system 1600
EZU Real-time clock
FMS [sic] Teleprinter
KMBG Cartridge magnetic-tape device
LBL Punched-tape reader
LBS Punched-tape puncher
LK Line concentrator 4221
LPS Laboratory and process automation
OPS Operational memory with CM 8001
OSS Operational memory with U 202 D
PFS Read-only memory
PRZ Programming attachment
SD Serial printing unit 1156
SD Column printer 1154
TAS Alphanumeric keyboard
ZVE Central processing unit

ZVZ ZVE attachment

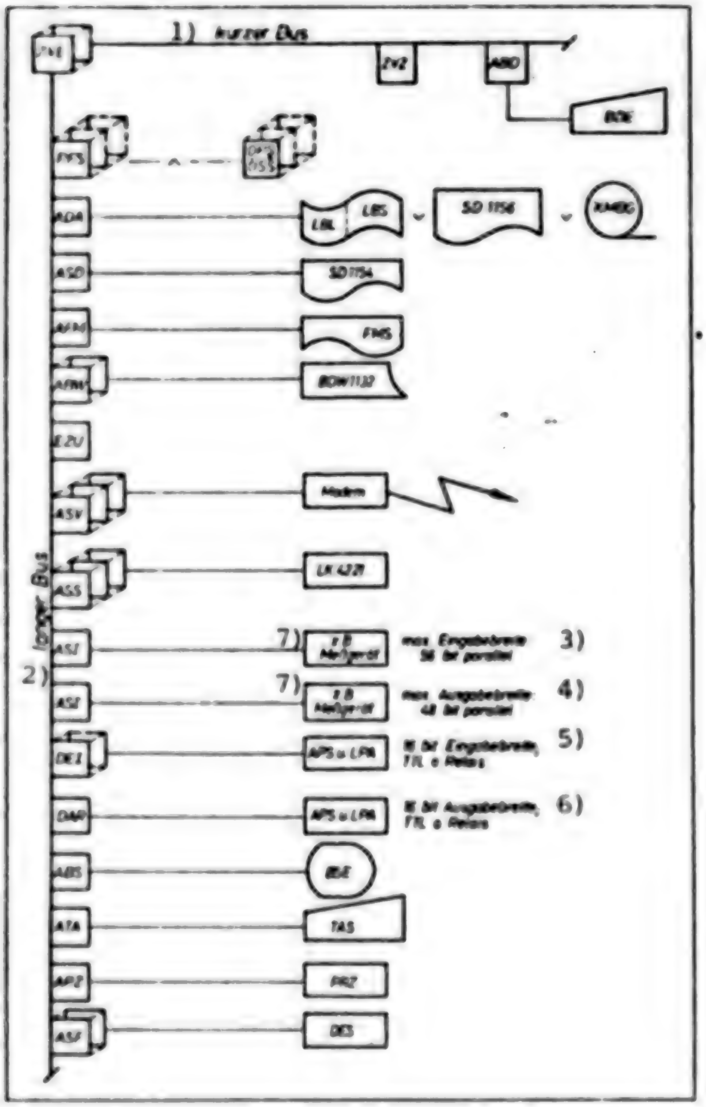


Figure 5: Systems Summary

Key:
1. Short bus
2. Long bus
3. Maximum input width: 56 bits parallel
4. Maximum output width: 48 bits parallel
5. 16-bit input width; TTL or relays
6. 16-bit output width; TTL or relays
7. Measuring device, for example

Table 4: Test Programs of the Mocrocomputer System K 1510

1) Bezeichnung	2) Programm-name	3) Programm-nummer	4) Verkaufs-form
5) ZVE-Test			
RAM	PRAM	K 403.01	1
		K 403.31	2
		K 403.61	3
6) Befehle	PBEF	K 403.02	1
		K 403.32	2
		K 403.62	3
7) Interrupt	PINT	K 403.03	1
		K 403.33	2
		K 403.63	3
8) Leitprogramm	LPRO	K 403.43	2
		K 403.73	3
9) Generier-programm	GCH 1	K 403.44	2
		K 403.74	3
10) AS-Test			
ADA	PADA	K 403.04	1
		K 403.34	2
		K 403.64	3
AFM	PAFM	K 403.05	1
		K 403.35	2
		K 403.65	3
ABS und 11) BSE	PBSE	K 403.06	1
		K 403.36	2
		K 403.66	3
ABD und 11) BDE	PBDE	K 403.07	1
		K 403.37	2
		K 403.67	3
ASI	PASI	K 403.12	1
		K 403.42	2
		K 403.72	3
ASV	PASV	K 403.16	1
		K 403.46	2
		K 403.76	3
DEI und DAR	PDAE	K 403.18	1
		K 403.48	2
		K 403.78	3
ABW	PABW	K 403.19	1
		K 403.49	2
		K 403.79	3
ASF	PASF	K 403.21	1
		K 403.51	2
		K 403.81	3
ATA	PATA	K 403.23	1
		K 403.53	2
		K 403.83	3
ASD	PASD	K 403.24	1
		K 403.54	2
		K 403.84	3
ASS	PASS	K 403.26	1
		K 403.56	2
		K 403.86	3
12) Peripherie-Test			
FSM	PFSM	K 403.08	1
		K 403.38	2
		K 403.68	3
LBL	PLBL	K 403.09	1
		K 403.39	2
		K 403.69	3
LBS	PLST	K 403.10	1
		K 403.40	2
		K 403.70	3
SD 1156	PSDR	K 403.11	1
		K 403.41	2
		K 403.71	3
BDW 1132	PBDW	K 403.20	1
		K 403.50	2
		K 403.80	3
DES 1600	PHAD	K 403.22	1
		K 403.52	2
		K 403.82	3
SD 1154	PSDS	K 403.25	1
		K 403.55	2
		K 403.85	3
KMBO 1250	PMBO	K 403.27	1
		K 403.57	2
		K 403.87	3
13) Baugruppen-Test			
TAS	PTAS	K 403.15	1
		K 403.45	2
		K 403.75	3
EZU	PEZU	K 403.17	1
		K 403.47	2
		K 403.77	3
14) PRA und E A-Adressen	PPEA	K 403.29	1
		K 403.59	2
		K 403.89	3
VKA	PVKA	K 403.30	1
		K 403.60	2
		K 403.90	3
PRZ	PPRZ	K 403.94	1
		K 403.95	2
		K 403.96	3
15) AKM-Netz-fehlerunter-brechung	PNFI	K 403.92	2
		K 403.93	3

Key:
1. Designation
2. Program name
3. Program number
4. Dealer's format
5. ZVE testing
6. Instructions
7. Interrupt
8. Executive program
9. Generating program
10. AS testing
11. and
12. Peripherals testing
13. Components testing
14. PRA and E/A addresses
15. AKM power failure interrupt

Table 5: Necessary Test Equipment

2) Prüfung	1) Prüfmittel		
	3) Kurzschlußstecker	4) Kurzschlußkabel	5) Gegenschnittstelle
ASF K 4510	KAB K 0510.06		
ADA K 6010		KAB K 0510.04	
ASD K 6011		KAB K 0510.07	VKA K 0404
ABW K 6012		KAB K 0510.08	VKA K 0404
ATA K 7011		KAB K 0510.11	ASI K 9210
ATA K 7013		KAB K 0510.12	ASI K 9210
AFM K 8510	KAB K 0510.02		
ASV K 8511.01		KAB K 0510.01	ASV K 8511.02
ASV K 8511.02		KAB K 0510.01	ASV K 8511.01
ASS K 8512.01		KAB K 0510.20	ASS K 8512.01
ASI K 9210		KAB K 0510.03	ASI K 9211
ASI K 9211		KAB K 0510.05	ASI K 9210
DEI K 9212.01		KAB K 0510.16	DAR K 9213.01 oder 6) DAR K 9213.02
DEI K 9212.02		KAB K 0510.17	7) DAR K 9213.01 und 24 V, 120 mA extern 8)
DAR K 9213.01		KAB K 0510.16	DEI K 9212.01 24 V, 120 mA extern
		KAB K 0510.17	DEI K 9212.02

Key:
1. Test equipment
2. Test
3. Short-circuit plug
4. Short-circuit cable
5. Remote interface
6. or
7. and
8. External

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LICENSES USED TO DEVELOP COMPUTER ENGINEERING OUTPUT IN ROMANIA

Budapest SZAMITASTECHNIKA in Hungarian Jul-Aug 79 p 9

[Article by Mrs Istvan Toth: "Developments in Romania--On the Basis of Licenses"]

[Text] Computer technology development, manufacture and applications guidance are completely centralized in the Romanian Socialist Republic. The "Automation and Computer Technology Syndicate" (CIETC) employs 48,000 people in 15 factory units and has an annual production value of 11 billion lei. In addition to the factories the framework of the syndicate includes research institutes dealing with development and a few middle schools training special experts. Two factories, the Peripherals Factory (ROM CONTROL DATA) and the Computer Technology Factory, produce 28 percent of the production value of the syndicate. Their development is extraordinarily dynamic. During the next five-year plan they plan to increase manufacture by 2.5 times, as compared to 1980.

Peripherals

The Peripherals Factory was founded in 1974 as a joint enterprise, with 55 percent of the investment being Romanian and 45 percent being the share of CONTROL DATA. The assembly of card readers, disk units and line printers and associated activity takes place on a complete license basis in a basic area of about 4,000 square meters. CONTROL DATA provides 70-75 percent of the built in parts and materials. This is gradually being replaced with domestic products. A large part of the production of the factory returns to the CDC. All marketing (even domestically) takes place exclusively for dollars, which greatly hinders purchases by socialist countries.

The well organized, disciplined work makes an extraordinarily favorable impression on the visitor. The productivity index for the factory is favorable (according to the information received it far surpasses the national average).

The following equipment is produced in the factory:

--Car readers. The Elektronum 9226 (300 or 600 cards per minute) and 9228 (300, 400, 600, or 800 cards per minute) models are reliable and economical

pieces of table equipment which can be operated at both computers and terminals. In addition to the 80 column and 51 column punch cards they are also suitable for optical (mark sensing) reading.

--Line printers. The three models belonging to the CDC R 9380 family of chain printers (the 9383 at 300 lines per minute, the 9386 at 600 lines per minute and the 9389 at 900 lines per minute) can be used changeably with character sets of 48, 64, 96 and 128, and are suitable for densities of 10 or 15 lines per inch. The 9322 model is a drum printer with a speed of 400 lines per minute. The 64 character set has a character/line width of 132 with a vertical density of 6 or 8 lines per inch.

--Disk units. The 9742 model disk unit has a capacity of 58 Mbytes with random access. It is completely compatible with the similar units of IBM. The IBM 2316 or the CDC 9869 can be operated with disk packs of 11 disks (20 working surfaces). The characteristic data are: a nominal capacity of 7,812 bytes per track, a density of 2,220 bits per inch (inside track) or 1,530 bits per inch (outside track) and 406 tracks per disk surface. The average query time is 35 ms-400 cylinders. The average access time on one track is 10 ms.

The CDC 23142 is a multiple disk storage system consisting of a control unit and a maximum of eight 23122 model disk units (with parameters similar to the above).

Computers

The Computer Technology Factory developed the "Felix" family on the basis of a FRIDEN accounting machines license and the family consists of the FC 32, FC 64 and FC 96 accounting-billing systems.

The Felix 256 and 512 computers (the model number indicates the memory capacity) are manufactured on the basis of the IRIS 50 model of the CII. The machines for the national computer net come primarily from these. The factory also manufactures the DAF-1001 alphanumeric display and the INDIPENDENT-100 universal minicomputer.

In connection with applications these are a few data concerning the computer net now operating in the country:

	Medium and large computers	Small and mini-computers
Bucharest	75	96
Provinces	85	174
Average number of shifts	2.3	1.4
Average number of personnel	100 per computer	25 per computer

The large computers operate as regional service centers under the direction of the Informatics Institute. Only in extraordinary cases (and if the computer center testifies that it is unable to satisfy the information processing needs of the given enterprise or institution) can other organs acquire a computer independently.

The functions of a national service network are performed by the IIRUC enterprise which employs 4,600 people, also within the framework of the above mentioned CIETC syndicate.

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